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74	Legal Representative: F. Vomberg, Dipl. Phys. [Qualified Physicist], Patent Attorney, 42653 Solingen	56	Publications to be considered for the assessment of patentability DE 33 47 501 A1 DE 32 08 282 A1 US 41 37 106 EP 07 30 926 A1 EP 07 20 879 A2 EP 06 91 167 A1 EP 06 38 383 A1 EP 02 83 464 A2 EP 02 57 869 A2

54 Compound component and method for producing same

57 The invention relates to a compound component consisting of at least two parts with different material compositions. At least one such part consists of hard metal or a cermet. The parts are joined into a single component by a concluding sinter process, and the joining surface between the two parts is uneven. In order to produce such a compound component, granulate mixtures in powder form are produced corresponding to the material composition of the individual parts, which are layered, precompacted jointly and subsequently sintered.

The following information was taken from the documents filed by the applicant.

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Specification

The invention relates to a compound component consisting of at least two parts with different material compositions. At least one such part consists of hard metal or a cermet, and the parts are joined into a single component by a concluding sinter process. The invention also relates to a method for producing said compound component starting with granulate mixes in powder form with different compositions which are finally joined into a single uniform component by means of sintering.

GB-A 1 115 908 already described a compound component consisting of a hard metal substrate component and a surface coating that substantially contains a carbide of one of the elements of the IVa or Va group of the periodic table system with a low cobalt content. For producing said compound component, it is proposed to precompact the first powder mix corresponding to the composition of the substrate component, followed by applying a thin layer of the second powder corresponding to the desired composition of the coating and pressing it at a higher pressure jointly with the substrate component before the green compact thus produced is sintered. GB-A-1 042 711 describes a respective method for producing a cutting tool and additionally specifies a surface layer thickness between 12 µm and 1.2 mm.

AT-C-269 598 relates to a sintered indexable insert for metal cutting tools consisting of a core of a tenacious material and outside layers of abrasion-resistant and wear-resistant hard metal, where the two outside surfaces of the cores are only partially covered, preferably no more than 50%, by the outside layers serving as work surfaces. In order to produce such an indexable insert, an insert of rubber or similar elastic material is placed centered in a standard mold. The thickness of the insert is equivalent to the desired thickness of the outside layers and it has the shape of the outside surface of the indexable insert to be formed by the core material. The space between the insert and the mold wall is filled with the starting powder for one outside layer and the filled-in powder is compacted into a shaped component. Then the insert is removed, the bottom die is lowered in accordance with the desired thickness of the indexable insert, the mold is filled with the starting powder for the core, leaving space for the desired outside layer by inserting an insert having the thickness and shape of the outside layers, the powder is compacted, the insert is removed, the empty space in the mold is filled with starting powder for the second outside layer, the powder is compacted and the shaped component produced such is sintered as usual. Consequently, the rubber insert reserves the space for the outside layer to be produced later. The core composition is listed as a hard metal consisting of 90% WC, 10% Co and the composition of the outside layers consisting of 10% Co, 14% TiC, 17.5% TaC, 58.5% WC or 10% Co, 35% TiC and 55% WC. Preferably, the indexable inserts thus sintered should undergo a concluding heat treatment at temperatures between 400°C and 800°C so as to reduce the tension and decrease the brittleness and porosity of the surface layers and thus preventing the indexable inserts from breaking or deforming.

DE 32 08 282 describes a method for firmly joining a first component of hard metal with at least a second component either consisting of hard metal with a different composition than the first component or of metal, where the first and second components are either in a final, sintered state or in a presintered state. They are in contact with each other while they are sintered, and no binder metal (solder) is used in the area where their surfaces are in contact. This is intended especially for producing metal machining tools, in which the first component is the cutting tip of the tool which can be joined to a holder consisting of steel, for example.

The compound components produced in accordance with the above described methods are found to be unusable in practical application because the adhesive strength of the joining surface between the two parts of the compound components consisting of different materials is inadequate. This is also true especially for thin-layered coatings which break down even under minor stress. Insofar as space holders have to be used for compression, for example according to AT-C-269 598, the methods are also relatively complex.

Therefore, the aim of the present invention is to provide a compound component as described above without the above outlined disadvantages, and therefore especially with adequate bonding of the joining surfaces between the two constituent components.

The problem is solved with the compound component of claim 1, characterized according to the invention in that the joining surface of the two parts is uneven, i.e. it is rough or provided with contours. The mean surface roughness is preferably at least 100 µm. The joining surfaces can deviate regularly or irregularly in shape (from an even surface) in the second or a higher degree, preferably being wavy, jagged, grooved, provided with indentations, elevations and/or scales.

Surprisingly, it was found that an uneven joining surface between two parts provides better bonding than a smooth joining surface with which previously, possibly even applying pressure or with weight support, the bonding was assumed to be stronger as a result of fusing and subsequent setting.

The compound component of the invention preferably consists of a substrate component of a first material and at least a second material on at least one surface or a part of a surface of the substrate component, where, according to a further development of the invention, the surface of the first material has the same impressed contour as the outside surface of the second material. Especially when a compound component is produced for a cutting tool for chip removal, said contour can have the geometry of the face, i.e. chip forming elements, such as grooves, indentations and/or elevations in the forms known from prior art. The geometry of the face, which is "repeated" at the place where the layer provided on the substrate component is joined, creates an uneven surface with relative interlocking causing better bonding for the surface layer on the substrate component.

Generally, cutting tools consisting of a core of a first material and an envelope of a second material, which is preferably wear-resistant, are configured as compound components. The core can be a ring cylinder, for example, with an uneven outside surface and the envelope can have a rhombic, square, rectangular or triangular outside cover, and the respective end faces of the core and the envelope are on a plane side by side and adjacent. The envelope parts forming the respective corners of the cutting edges then consist of a wear-resistant material while the inside ring is tenacious so as to have adequate flexural strength and/or breaking resistance.
The cutting tool can also consist of a multi-layered compound component whose separate layers from the support surface to the face or between two parallel faces are substantially disposed one on top of the other and the joining surfaces run either parallel with or at a sloping angle to the face. According to a special embodiment, the cutting tool is provided with a second material only in the area of the cutting edge corners.
Finally, it is possible to provide different material compositions for each cutting edge corner area, including adjacent faces and flank sections in each cutting edge corner, so as to optimize each cutting edge corner for a different cutting purpose.
With the particular selection of the powder types specific non-homogeneities and/or compressive and tensile stresses, including implanting subsequent crack forming centers, can be introduced in the joining surfaces.
The production of the above described compound component is based on granulate mixes in powder form, preferably with a granulation between 60 and 200 µm for a wide grain size spectrum, corresponding to the material composition of the individual parts, which are layered one on top of the other, successively, if applicable, precompacted jointly and finally sintered. The high average granulation of the starting mixes combined with a wide grain size spectrum (for example from 60 µm to 250 µm) causes the loosely layered powder mixes to have an uneven boundary area following the interface of their flowing ability. By compacting the layered mixes jointly, said effect intensifies so that even a green compact has a relatively high adhesive power on the joining surfaces of the two compound components consisting of different materials. The concluding sinter process creates a tight bond on said joining surface.
Alternatively, the first granulate mix in powder form is placed in a press, and said first mix is compacted by lowering a top die with an impressed contour, preferably under a pressure between 0.05×10^7 to 50×10^7 Pa (5 to 5000 bar). The contoured surface created by the pressure die, which will subsequently correspond to the joining surface, is filled with another layer of a second mix, preferably covering the impressed surface completely. Then the same pressure die is lowered again so as to press on the top layer under the same pressure as specified above or under another pressure. Said top layer preferably has a uniform thickness, which allows using a pressure die that has the geometry of a face of a cutting tool to be produced with the respective chip forming indentations, grooves and ribs which will then be impressed into the first substrate component.

The second mix is applied to said substrate component surface in the desired layer thickness and pressed on using the same die so that the second formed surface corresponds to the subsequent cutting tool face. When the sinter process is completed, the composition obtained on the face is different from that of the substrate component. As described above, the (uneven) joining surface, which is identical to the geometry of the face, provides good bonding between the substrate component and the surface layer because of the existing elevations and indentations in connection with the above discussed granulate granulation and the grain boundary spectrum.

Depending on the desired layering and the structure of the multi-part compound component, precompacting can be radial and/or axial. As mentioned above, a pressure die is used for impressing a cutting tool surface, which has the negative contours of a face of a cutting tool provided with chip forming elements, preferably with maximum indentations/elevations relative to the principal surface between 1 μm and 2 mm.

Exemplary embodiments of the invention are illustrated in the drawings, as follows:

Figs. 1 to 5 show schematic sectional views of compound components consisting of two or more parts;

Figs. 6a, b show a top view and a sectional view of a rhombic cutting tool with a substantially cylindrical core;

Figs. 7a, b, c show a rhombic cutting tool consisting of three or five layers of different materials in a top view and two sectional views;

Figs. 8a, b show a rhombic cutting tool with coatings of a different material applied on the cutting edge corners;

Figs. 9a, b show a cut-off tool consisting of two parts;

Figs. 10a, b, c show another rhombic cutting tool with a core component and a surface coating around said core and for reinforcing the corners;

Figs. 11a, b show a trigon-shaped cutting tool consisting of two different materials;

Fig. 12 shows a trigon-shaped cutting tool consisting of three material segments;

Figs. 13a, b show another rhombic cutting tool consisting of two materials, and

Figs. 14a, b show a rhombic cutting tool with chip forming elements molded on the face.

The following explanations of the drawings should be prefaced by saying that generally, with the compound component of the invention, parts of hard metal (incl. cermets) can be produced having better functional properties and/or at lower production costs, and the parts have different material compositions. Therefore, mechanical properties, such as breaking resistance, flexural strength, and wear resistance can be realized because of the special functional structure in the form of a layered compound, not because the individual powders have better alloy properties, which surpass those produced with uniform parts from individual powders and with a homogeneous structure.

Especially chip removing tools and other components of hard metal can be produced so as to have better application properties, such as wear-resistant cutting and tenacious areas on the face (resistant to chip impact). The production of such components is uniform in that different hard metal powders are finally compacted into a single green compact and in that it is subsequently sintered. The compacting pressure and the sintering conditions (temperature, pressure, sintering atmosphere) are equivalent to those generally used for producing sintered components by powder-metallurgy.
As shown in Fig. 1, a single compound component 20 can be created from two parts 21 and 22 with a common joining surface 23 which is uneven. For producing said compound component, a first mix followed by a second mix are loosely layered by filling a compactor accordingly, where the mixes differ with regard to their material composition and are used in granular form. With an exceedingly wide grain size spectrum the grain size ranges between 60 µm and 250 µm. Subsequently, the two mixes are compacted into a uniform green compact by lowering a pressure die under a pressure of up to 50 x 10^7, followed by finally sintering said green compact under normal sintering conditions. An uneven interface 23 firmly bonded on the joining surface 23 is thus obtained.
Alternatively, the compound component 24 also has two parts 25 and 26, but the joining surface 27 is geometrically defined, which is achieved by the following method:
First, a compacting space is filled with a first layer of a material composition in powder form having the respective grain size or grain size distribution, as mentioned above. Then, said material composition is precompacted by lowering a pressure die. Said die has a contour configured so as to correspond to the joining surface 27. Then, the pressure die is raised again and a second mix 25 is filled in, which is then compacted, possibly using a pressure die with a smooth surface. The green compact thus produced is then completed by sintering.
The compound component 28 shown in Fig. 3 consists of a multi-layer compound with layers 29 to 31 where tensile and pressure stresses can specifically be introduced into the component 28 by the selection of the materials so as to increase the breaking resistance and the flexural strength. A method as described in connection with Figs. 1 or 2 can be used for this. The compound component 77 of Fig. 4 differs from the one in Fig. 3 in that it has six layers 32 to 37 instead of three layers 29 to 31. In the compound component 38 of Fig. 5, specific non-homogeneities of one type of powder 39, for example of a granulate, were introduced into a matrix 40 of another type of powder and subsequently compacted and sintered so as to have a positive effect on the propagation of cracks or the like. Granulates of different powders 39, 40 are used for this.
The joining surfaces of the compound components 20, 24, 28, 77 and 38 are found to be exceedingly durable.

For parts that are difficult to compact, layer compacting two granulates with different compacting properties achieves a distortion compensation. In principle, high quality components can be produced with the present invention, such as the cutting tools described below, where one constituent part consists of a relatively low cost recycling material or inferior material and the other constituent part or parts consist of a high-quality material, such as hard metal or cermet. The compound components can be produced easily and without significant effort using the usual matrix presses and without requiring much time. The above described method of the invention provides the possibility of implementing into practice the advantages known in theory of layer compound materials for hard metals produced by powder-metallurgy.

Examples of actual applications are shown in Figs. 6 to 14. The cutting tool according to Figs. 6a, b consists of a substantially cylindrical core 41 and an outside envelope 42 whose outside cover is rhombic as seen from the top. In order to produce said tool with a center mounting hole 78, a first granulate mix of a first material composition is precompacted around a spike and an uneven outside surface is impressed radially on the outside cover. Then, said core 41 is placed into a press with a rhombic cross-section, centered, if necessary, and the edge area around the core is filled up with a second material, which is then compacted so as to form the rhombic shape as shown. A cutting tool is then obtained whose face areas near the cutting edges and whose flank [consist] of a different material like the core 41 forming the center of the face on the front.

The cutting tool according to Fig. 7 consists either of three layers 43, 44 and 45 or of a multi-layer package 46, where the layers 43 and 45 can form the support surface and the face or two faces. The same applies accordingly to the outside layers of the layer package 46.

In the cutting tool according to Fig. 8a, the sharp corner areas 48 are made of a different material than the core 47. The joining surface 49 runs at a sloping angle relative to the flank and the face, where it ends.

The compound component of the invention consisting of two parts 50, 51 can also be configured as a cutting-off tool whose roof area (face) and the underlying layer of material 50 consist of a different material, like the basic component 51.

The rhombic cutting tool according to Figs. 10a, b substantially corresponds to that according to Figs. 6a, b, but with the difference that the core 52 itself is configured rhombic on the outside cover 53, and the joining surface 53 is uneven and substantially parallel with the outside circumference (cutting tool flanks). The outside layer 54 consists of a hollow body whose inside and outside covers are rhombic. The embodiment variant shown in Fig. 10 consists of a core component 56 and respective corner zones 55 configured as described in connection with Figs. 8 a, b.

The trigon-shaped cutting tool according to Fig. 11a has chip forming indentations 79 running parallel with the cutting edges all around. The component itself consists of two different materials 57 and 58 with an uneven joining surface 59.

The material compositions of the layers 57 and 58 can consist of the hard metals P15 and P20, for example.
The substantially triangular cutting tool shown in Fig. 12 has roof-like edges 60, a chip forming groove 61 and a center plateau area 62 from which rib-like wedges extend as chip forming elements 63 to each cutting edge. Along respective joining surfaces 64, 65 and 66 different constituent components 67, 68 and 69 extend on both sides. Said constituent components were joined into a single cutting tool by means of compacting and subsequent sintering. The joining surfaces 64 to 66 substantially extend vertically relative to the visible roof area down to the bottom area.
The sharp-edged rhombic cutting tool shown in Figs. 13a, b with a graduated flank 70 consisting of parts 71 and 72 of different materials can also be produced by means of the above described method. For the cutting tool shown in Figs. 14a, b, the invention was embodied such that recesses 74 were created in a precompacted core 73 of a first material by respectively applying a top and bottom die. The recesses are filled with a second material 75 and precompacted by subsequent compacting using a respectively configured pressure die so as to produce (preformed) chip forming elements 76. The precompacted component is subsequently sintered. All above described embodiments are variable with regard to their structure, but at least one of the layers or a constituent component should consist of a hard metal or a cermet of a type known from prior art. The remaining parts can consist of other hard metal or cermet (for indexable inserts) compositions or even steel (for compound components with anti-wear protection). The selected layer thickness, including the surface layers can vary widely to the extent allowed by the compacting methods, as long as the condition of the invention – a rough joining surface with an irregular or regular structure – is met.

Patent Claims

1. Compound component consisting of at least two parts with different material compositions, at least one of the parts consisting of hard metal or a cermet, and joining said parts into a single component by a concluding sinter process, characterized in that the joining surface of the two parts is uneven.

2. Compound component as defined in claim 1, characterized by a joining surface with a mean surface roughness of at least 100 µm.

3. Compound component as defined in claim 1 or 2, characterized in that the joining surface deviates regularly or irregularly in shape (from an even surface) in the second or a higher degree, preferably being wavy, jagged, grooved, provided with indentations, elevations and/or scales.

4. Compound component as defined in claim 3, characterized in that said component consists of a substrate component of a first material and at least one second material on at least one surface or part of a surface of the substrate component, where the surface of the first material preferably has the same impressed contour as the outside surface of the second material.

5. Compound component as defined in any of the claims 1 to 4, characterized in that said compound component consists of a core of a first material and an envelope of a second material, preferably configured as a cutting tool.

6. Compound component as defined in claim 5, characterized in that the core is a ring cylinder with an uneven outside surface and the envelope has a rhombic, square, rectangular or triangular outside cover, where the respective end faces of the core and the envelope are on a plane side by side and adjacent.

7. Compound component as defined in claim 5 or 6, characterized in that the cutting tool consists of a multi-layer compound component whose individual layers from the support surface to the face or between two parallel faces are substantially disposed one on top of the other.

8. Compound component as defined in any of the claims 5 to 7, characterized in that the cutting tool is provided with a second material only in the areas of the corners of the cutting edges.

9. Compound component as defined in any of the claims 5 to 8, characterized in that at least on two adjacent cutting edge corners adjacent cutting tool parts of a different material are provided.

10. Compound component as defined in any of the claims 1 to 9, characterized in that by the selection of the powders specific non-homogeneities and/or compressive or tensile stresses, including implanting subsequent crack forming centers are introduced.

11. Method for producing a compound component as defined in any of the claims 1 to 10, characterized in that granulate mixes in powder form, preferably with granulations between 60 μm and 250 μm for a wide grain size spectrum, are produced corresponding to the material composition of the individual parts, and layered one on top of the other, successively, if applicable, jointly precompacted and finally sintered.

12. Method for producing a compound component as defined in any of the claims 1 to 10, where granulate mixes in powder form are produced corresponding to the material compositions of the individual parts, then a first mix is precompacted, preferably under a pressure between 0.05×10^7 and 50×10^7 Pa, where the pressure die for impressing the surface, which subsequently becomes a joining surface with another part, has an uneven contour, then a second mix is filled in, covering at least the impressed surface of the first precompacted component fully or in part, and said additional layer is precompacted with the first precompacted component before finishing the complete precompacted component by sintering.

13. Method as defined in any of the claims 11 or 12, characterized in that precompacting is radial and/or axial.

14. Method as defined in claim 12, characterized in that the pressure die for impressing the contoured surface has the negative form of a face of a cutting tool provided with chip forming elements, preferably with maximum indentations/elevations relative to the principal surface between 1 μm and 2 mm and that said same pressure die is used for compacting a first granulate mix and after applying a thin-layered second mix for precompacting the complete layer structure.

Attached 6 pages of drawings

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FIG. 3

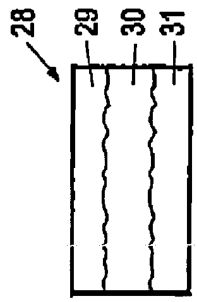

FIG. 2

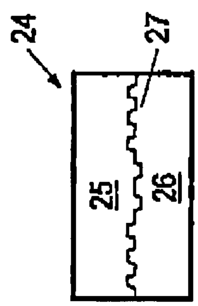

FIG. 5

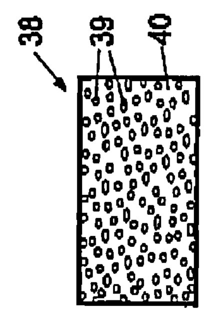

FIG. 1

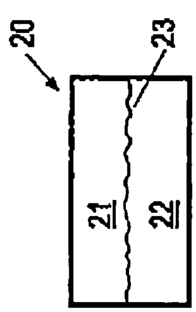

FIG. 4

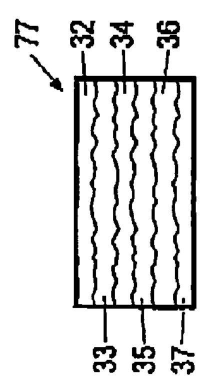

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FIG. 6a

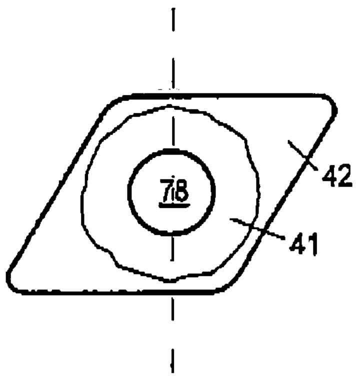

FIG. 6b

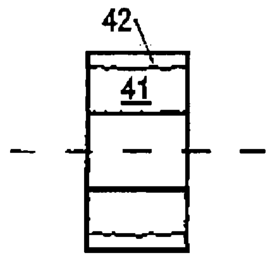

FIG. 7a

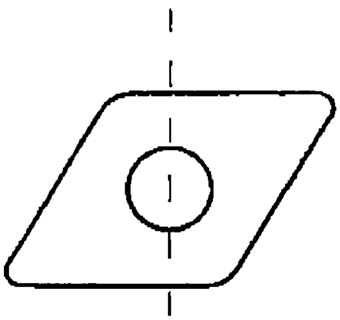

FIG. 7b

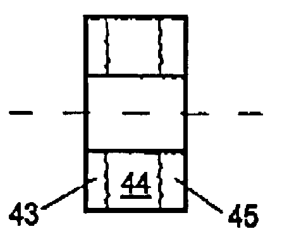

FIG. 7c

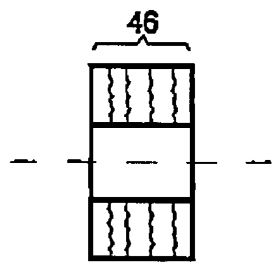

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FIG. 8a

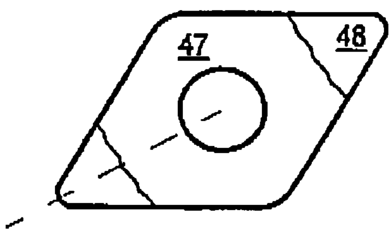

FIG. 8b

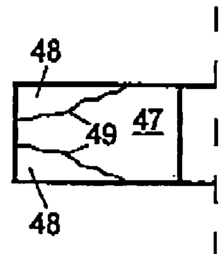

FIG. 9a

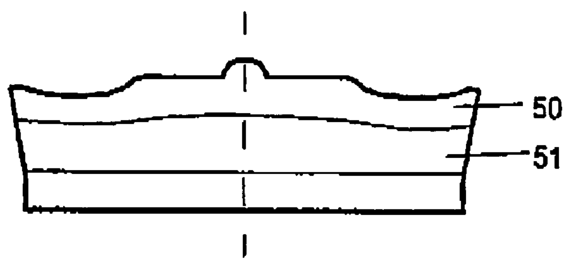

FIG. 9b

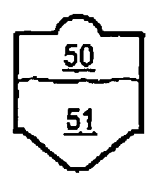

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FIG. 10a

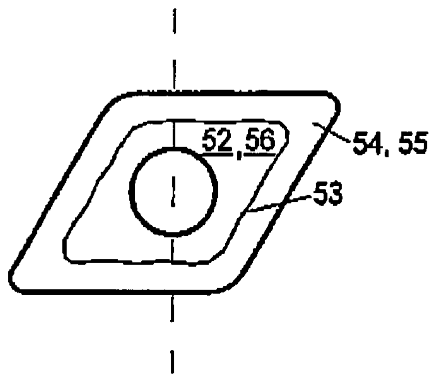

FIG. 10b

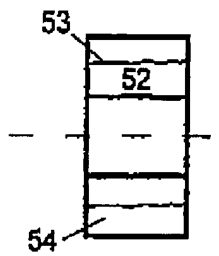

FIG. 10c

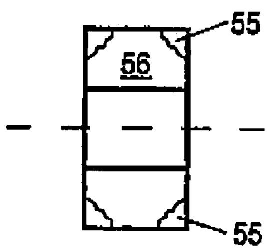

FIG. 11a

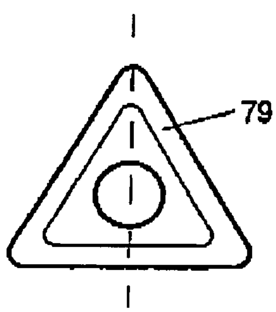

FIG. 11b

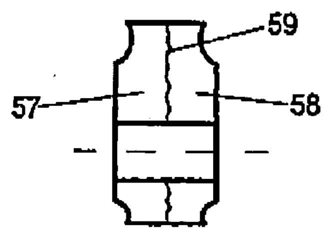

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FIG. 12

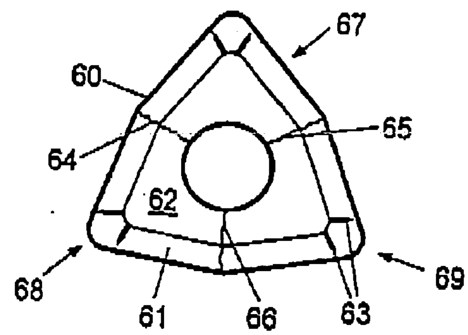

FIG. 13a

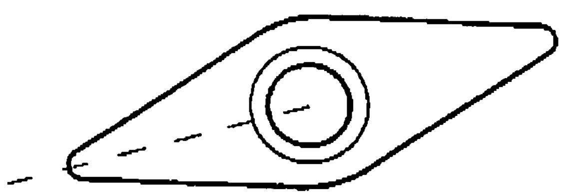

FIG. 13b

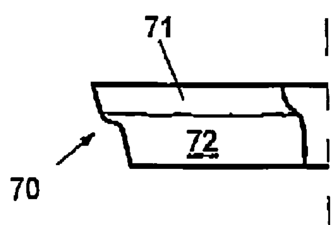

FIG. 14a

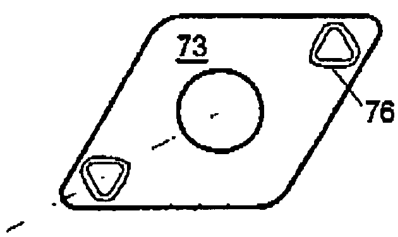

FIG. 14b